

AffinityWater

River Beane

Flagship Chalk Stream Catchment
Restoration Project

Scoping Document

October 2022



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Introduction

This scoping document has been prepared in line with a request from the Catchment Based Approach (CaBA) Flagship Programme Board as an intermediary stage to the production of a full catchment strategy by October 2023 and in advance of the November 2022 Water Industry National Environment Programme (WINEP) submission.

As part of the 2021 CaBA Chalk Stream Restoration Strategy, water companies with chalk streams within their supply areas, were asked to nominate chalk stream catchments to form a national network of flagship restoration projects. The ambition of the CaBA strategy is for each nominated catchment to be restored over a 10 year period, with the aim to realise and implement all aspects of the CaBA strategy and to act as exemplars to assist in the restoration of other chalk catchments. A set of criteria for nominating catchments was established and required the selection of chalk streams that were medium in length (c. 15km long), have active stakeholder engagement to drive projects forward and have the buy in from local landowners willing to participate.

In a letter to the then Parliamentary Under Secretary of State at the Department of Environment, Food and Rural Affairs, Rebecca Pow, in August 2021, Affinity Water proposed two catchments to be considered for the Flagship Restoration Project: The River Chess and the River Beane. The River Chess Flagship project is to be delivered in collaboration with Thames Water and a separate proposal is being prepared under the Smarter Water Catchments initiative.

This report details the scope of the Flagship Restoration project for the River Beane. It highlights historic and current challenges, current water quality, ecology and flow data, local projects, stakeholder engagement and will detail initial plans for delivering the restoration with some reference to costings and timescales where appropriate.

The River Beane Catchment

The River Beane is a chalk stream that flows in the county of Hertfordshire, England and is around 18km in length from source to its confluence with the Lea at Hertford. As a tributary of the River Lea, it rises to the south-west of Sandon, in the hills northeast of Stevenage and joins the Lea at Hartham Common in Hertford. It has been identified as failing to meet Good Ecological Status (GES) as defined by the Water Framework Directive (WFD) and was considered at risk of serious damage from the Affinity Water public water supply abstraction at Whitehall.

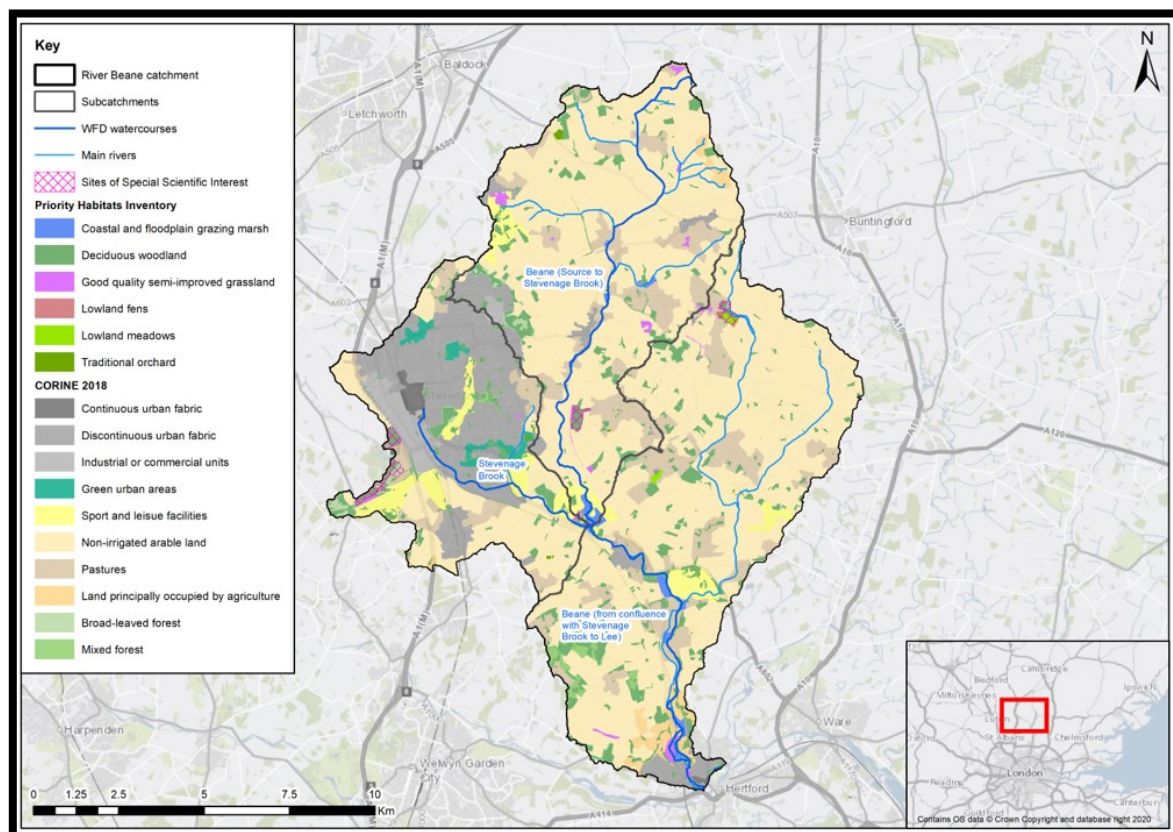


Figure 1. Land-use types across the River Beane catchment.

The catchment covers a predominantly rural area, with arable farmland and a number of small villages but also includes the urban areas of Stevenage and Hertford (**Figure 1**). Our work in the catchment has identified a wide range of pressures including agricultural, urban and road runoff, an extensive presence of invasive non-native species, historic channel modifications and land drainage issues.

A significant groundwater abstraction reduction has already been implemented in the catchment at Whitehall, with average abstraction reduced in 2017 from 18MI/d to 2MI/d. The in-combination effect of these pressures is resulting in poor water quality (e.g. increased turbidity, sediment loading), poor habitat and flow diversity, reduced connectivity and consequently poor chalk stream health.

The bedrock geology is represented by the Cretaceous Chalk sequence, dipping uniformly and gently to the southeast, with the addition of Tertiary deposits distributed only on marginal areas. The Upper Chalk units of Lewes and Seaford Chalk (LESE-CHLK) cover most of the catchment bedrock, whilst along the main Beane valley and the Stevenage Brook, erosion exposed the underlying New Pit Chalk (HNCK-CHLK). The Chalk Rock (CKR-CHLK) is found at elevations ranging from 75 to 115 mAOD.

In general terms, the buried valleys with coarse material infilling, act as drain elements for shallow groundwater and surface water; often they are offset from the modern river channel and they can temporarily divert and/or convey surface water and shallow groundwater from/to the river system. The embedded presence of diamicton, when close to the surface, significantly prevents vertical interaction of groundwater with the riparian zone. Thus, highlighting complex interactions between surface flow and groundwater flow.

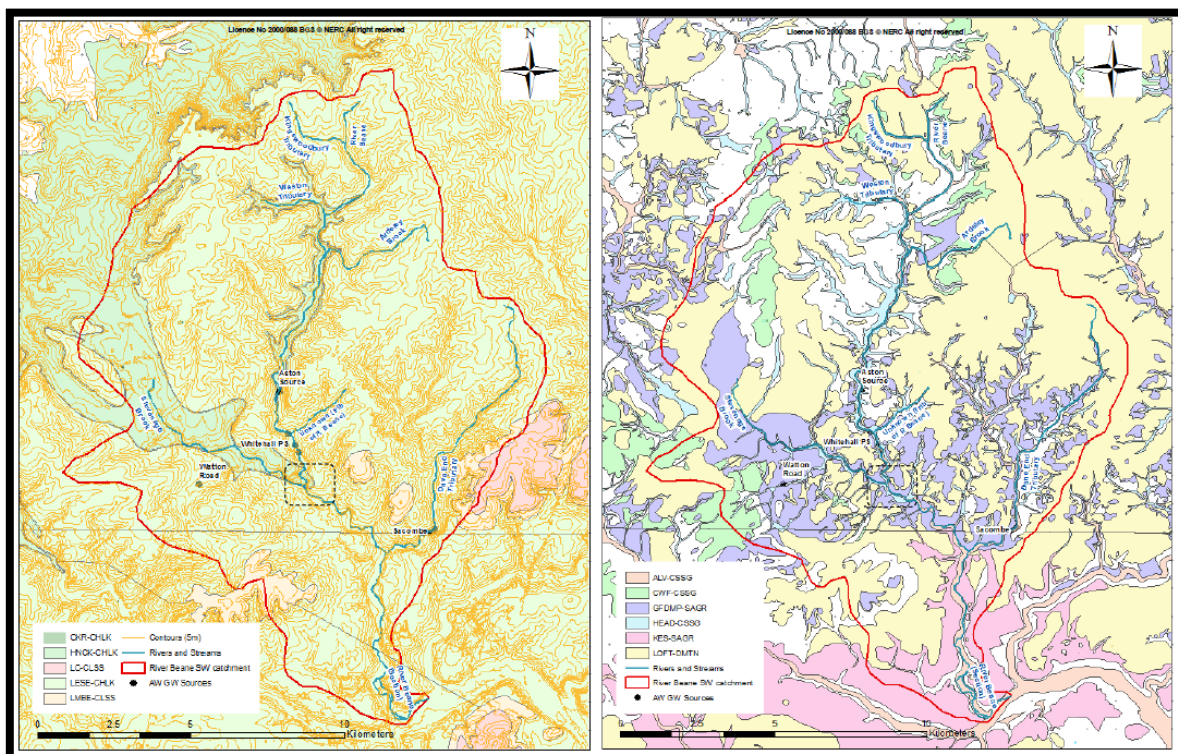


Figure 2. Solid geology (left) and drift geology (right) of the Beane catchment.

Table 1. Water Framework Directive classifications for the three sub-catchments: Beane (from confluence with Stevenage Brook to Lee), Beane (Source to Stevenage Brook) and Stevenage Brook.

Beane (from Confluence with Stevenage Brook to Lee)	2013	2014	2015	2016	2019
Ecological	Poor	Poor	Poor	Poor	Poor
Biological quality elements	Poor	Poor	Poor	Poor	Poor
Physico-chemical quality elements	Good	Good	Moderate	Moderate	Moderate
Hydromorphological Supporting elements	Supports good	Supports good	Supports good	Supports good	Supports good
Specific pollutants	Moderate	Moderate	High	High	High
Chemical	Good	Good	Good	Good	Fail
Priority hazardous substances	Good	Good	Good	Good	Fail
Priority substances	Good	Good	Good	Good	Good
Beane (Source to Stevenage Brook)	2013	2014	2015	2016	2019
Ecological	Moderate	Bad	Poor	Poor	Poor
Biological quality elements	Moderate	Bad	Poor	Poor	Poor
Physico-chemical quality elements		Moderate	Moderate	Moderate	Moderate
Hydromorphological Supporting elements	Supports good	Supports good	Supports good	Supports good	Supports good
Specific pollutants	High	High			
Chemical	Good	Good	Good	Good	Fail
Priority hazardous substances	Good	Good	DNRA	DNRA	Fail
Priority substances	Good	Good	DNRA	DNRA	Good
Stevenage Brook	2013	2014	2015	2016	2019
Ecological	Poor	Poor	Poor	Poor	Poor
Biological quality elements	Poor	Poor	Poor	Poor	Poor
Physico-chemical quality elements			Moderate	Moderate	Moderate
Hydromorphological Supporting elements	Supports good	Supports good	Supports good	Supports good	Supports good
Specific pollutants	Moderate	Moderate	High	High	High
Chemical	Fail	Fail	Good	Good	Fail
Priority hazardous substances	Fail	Fail	Good	Good	Fail
Priority substances	Good	Good	Good	Good	Good

The River Lea Catchment Partnership

River Beane Catchment Management Plan

The River Lea catchment partnership and associated partnerships for each river, including the River Beane were formed between 2012 and 2014. The River Beane partnership is hosted by the Herts and Middlesex Wildlife Trust (HMWT) alongside partners including: The Environment Agency (EA); River Beane Restoration Association (RBRA); Affinity Water; Countryside Management Service (CMS); local parish councils, Stevenage Borough Council and landowners in the catchment.

<http://www.riverleacatchment.org.uk/index.php/river-beane-home>

Objectives for the river

The objectives for the River Beane were developed during a number of workshops held during Autumn 2012. People and organisations with a stake or an interest in the river were asked to suggest their ideas about what the aims of the Catchment Management Plan should be.

The final list of eight objectives was divided into four themes: Flow; Water Quality, Habitats and Wildlife; People; and Status and Monitoring.

It should be noted that a similar process has been followed with the initial Scoping Workshop for this project detailed in the Flagship Project Scoping Workshop section of this report.

Aims for the river

The aims of the Beane Catchment Plan are to address:

Flow

- A. That there is water flowing along the whole length of the river at all times (excluding historic winter flowing sections)
- B. That there is adequate flow along the length of the river to support a 'good status' chalk stream ecology (as defined by Water Framework Directive)

Water Quality, Habitats & Wildlife

- C. That whatever the flow level, the river and its associated habitats, including banks and floodplains, are managed to support chalk stream species
- D. That water quality, temperature and riverbed quality are such that they support chalk stream ecology

People

E. To increase the attractiveness, visibility and public access, to enable people to appreciate the river (commensurate with managing and protecting sensitive habitats and species)

F. To increase the public's appreciation of the unique chalk stream environment and their participation in its conservation

Status & Monitoring

G. To achieve the highest possible level of legal protection for the river

H. To monitor the status of the river and its species to gauge if its condition is improving

An important component of the River Beane CaBA Flagship Chalk Stream Catchment Restoration Project will be to work with the Catchment Partnership to review the current status of the Catchment Plan, review the themes, objectives and aims and develop this Catchment Strategy building on the fantastic work already undertaken through this partnership.

River Beane Restoration Association

The RBRA was formed in 1991 with the main objectives of improving the environment and resolving the issue of low flow in the Beane catchment. The RBRA have had an active presence in the catchment, lobbying for abstraction reductions and working to deliver improvements in the catchment.

The RBRA run a river warden scheme as well as monitoring groundwater levels, undertake invasive non-native species (INNS) management and Riverfly monitoring. They play a vital role of being the 'eyes and ears' in the catchment if any pollution incidents or significant issues arise. The RBRA are a key partner to work with to help realise the goals of the flagship restoration project.

Monitoring in the Beane catchment

As part of our programme of reducing abstraction in the catchment, an assessment of existing monitoring within the Beane catchment was undertaken to identify hydrological and ecological changes pre- and post-implementation.

Baseline monitoring was established in 2014 from which to assess the response to AMP6 works. The reduction to 2 MI/d average and 10 MI/d peak was implemented on 1 April 2017, 12 months earlier than our original PR14 date. Environmental monitoring of the response to this reduction in abstraction is ongoing and we have presented our findings to date to the EA through a series of workshops and to local stakeholders. We will continue to liaise and work with stakeholders in the catchment, sharing and discussing our work.

Historic and Current Monitoring

Gauging Stations

There are two continuous flow monitoring stations located within the River Beane catchment; the upper gauging station is located in the Stevenage Brook at Bragbury Park, upstream of the confluence with the Beane, whilst the lower gauging station is located in the River Beane at Hartham upstream of the confluence with the River Lea. There are also three flood alert stations located at Walkern, Watton-at-Stone and Hartham.

The different flow characteristics of the two sub-catchments measured at the permanent gauging stations are reflected in the baseflow indexes, flow values and trends. The Stevenage Brook is draining a small area of only 36 km² which is mostly urban (Stevenage); consequently, the flow at the gauging station is runoff dominated, fluctuating significantly on a daily basis and in response to rainfall events. Despite its flashy nature, the Stevenage Brook provides a minimum baseflow to the Beane of c.1 Ml/d, with no known episodes of complete dryness and shows some seasonal trends consistent with the expected groundwater seasonal variation. The Beane at Hartham monitors flows draining from the whole catchment of 175 km² and exhibit a relatively high baseflow index (0.75), with flow at the gauging station being influence by groundwater base flow.

Rainfall Gauges

The Environment Agency monitors rainfall at three rain gauges in the catchment at Weston sewage treatment works (STW), Stevenage and Dane End. Weston STW, located at the northwest edge of the catchment, and Dane End, located in the tributary on the east catchment, have the longest and most reliable data records (from April 1991 to date and from November 1989 to date, respectively), whilst Stevenage has been recording since 2005.

Spot Gauging

Historic Environment Agency flow spot gauging data are available for the Beane catchment since 1973, although recorded at infrequent intervals. More systematic monitoring was undertaken during 1991 - 2000 period and recently by Affinity Water monthly from 2014 to present, as part of the AMP6-7 programme.

Riverfly Monitoring

Riverfly monitoring is a citizen science approach to rapidly assessing the health of rivers and impact of pollution events. Numerous Riverfly monitoring sites are active in the River Beane catchment:

Table 2. Historic and active Riverfly monitoring location in the Beane catchment.

Location	Sampling Start	Sampling End
Church End, Walkern	August 2014	September 2016
Aston End	November 2014	To present
Stevenage Brook, Wychdell Flood Reservoir	September 2015	To present
Lammas Control	August 2013	To present
Watton Lammas Road	August 2013	December 2019
Nursery, Woodhall Estate	August 2013	December 2019
Woodhall Upper	November 2020	To present
Woodhall Lower	November 2018	To present
Stapleford Church	August 2013	To present
Bulls Mill, Waterford Heath	August 2013	To present
Waterford Marsh	August 2014	To present
Hartham Common	August 2014	February 2015

RBRA Borehole Measurements

The RBRA undertake monitoring of nine groundwater boreholes installed by the National Rivers Authority, as part of the original Alleviation of Low Flow (ALF) study. The boreholes have been dipped on a monthly basis since 1996 and data can be found on their website (<https://www.riverbeane.org.uk/about-us/what-we-do/borehole-measurements/>).

- Halls Green
- Cromer
- Winters Lane
- Walkern Mill
- Aston End
- Aston Ford
- Holbrook
- Whitehall
- Watton

Affinity Water's Monitoring Programme

An extensive monitoring programme was created for AMP6 to monitor the hydrological and ecological response to the sustainability reduction at Whitehall and the river restoration work across the catchment.

Table 3. Summary of Affinity Water's active monitoring programme in the Beane catchment.

Type	Number of Locations	Frequency
Barometric Pressure	1	Hourly
Fixed Point Photography	9	Quarterly
Groundwater Level	13	Hourly
Macroinvertebrates	16	Biannual (spring/autumn)
Macrophytes	14	Annually
River Level Logger	1	15 minutes
Spot Gauging	20	Monthly

Spot Gauging

Spot gauging data was collected across 13 locations during the AMP6 cycle and enabled a sound conceptualisation of the surface water flow pattern along the Beane channel (**Figure 3**), from the source to the confluence with the River Lea, with particular focus on the reaches between Whitehall and Watton-at-Stone. The number of spot gauging monitoring points has since increased to 20 locations and is critical in aiding our understanding of the interactions between groundwater and surface water.

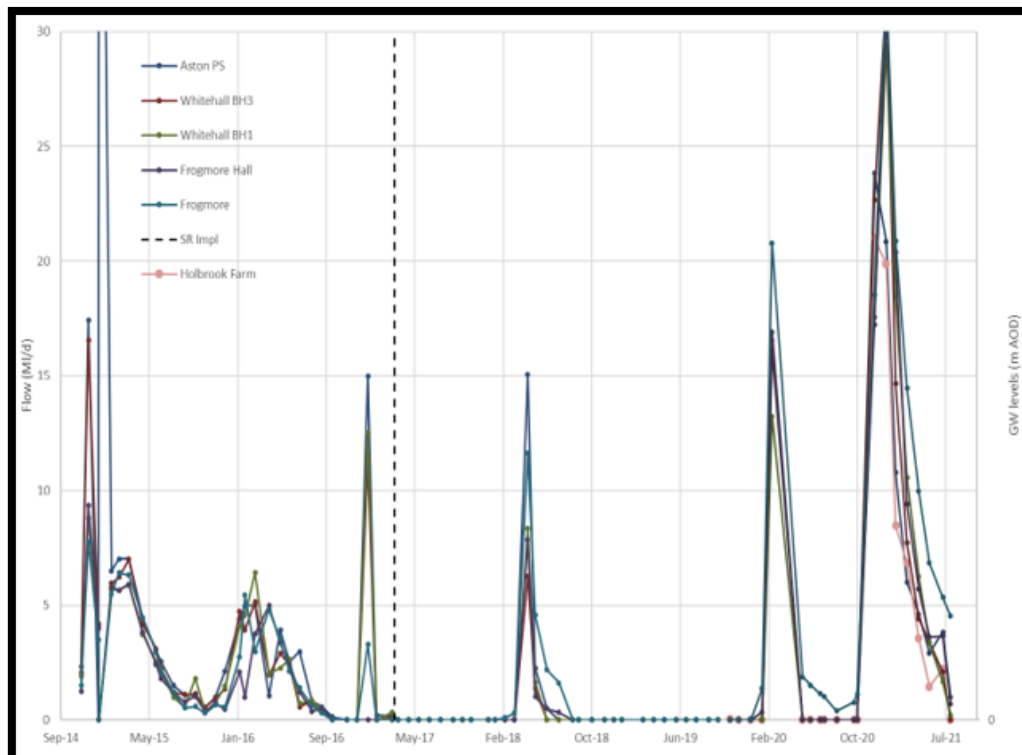


Figure 3. Graph of baseflow at Aston and Whitehall with spot gauging data.

Groundwater Level Monitoring

In the Beane catchment, groundwater levels are continuously monitored using borehole pressure transducers.

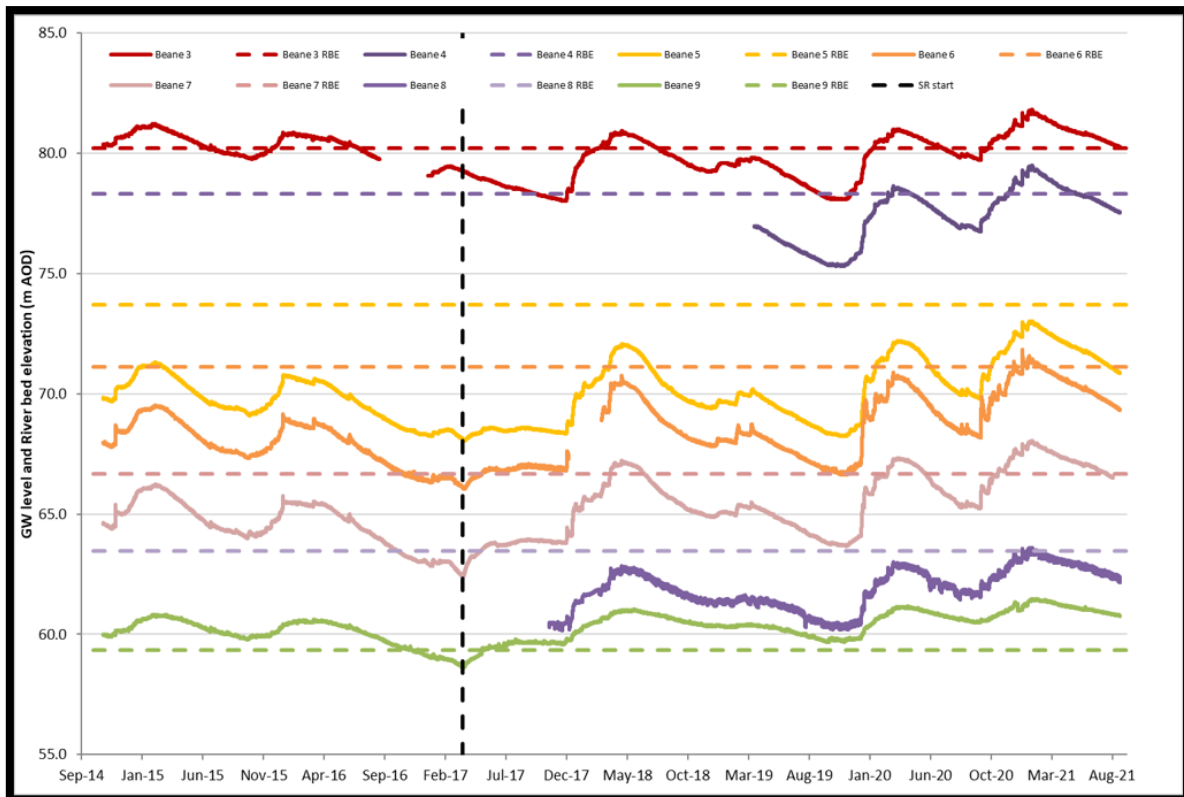


Figure 4. Graph of groundwater level in comparison to riverbed elevation (mAOD) pre- and post- sustainability reduction (black dashed line).

Macroinvertebrates and Macrophytes

Macroinvertebrate surveys are undertaken biannually during the spring and autumn seasons at 16 locations across the Beane catchment. Macrophyte surveys have continued to be undertaken annually at Affinity Water sampling locations with 11 sites on the River Beane and three on the Stevenage Brook. A further set of samples has been made available by the Environment Agency, covering 86 sites over 1994 - 2018.

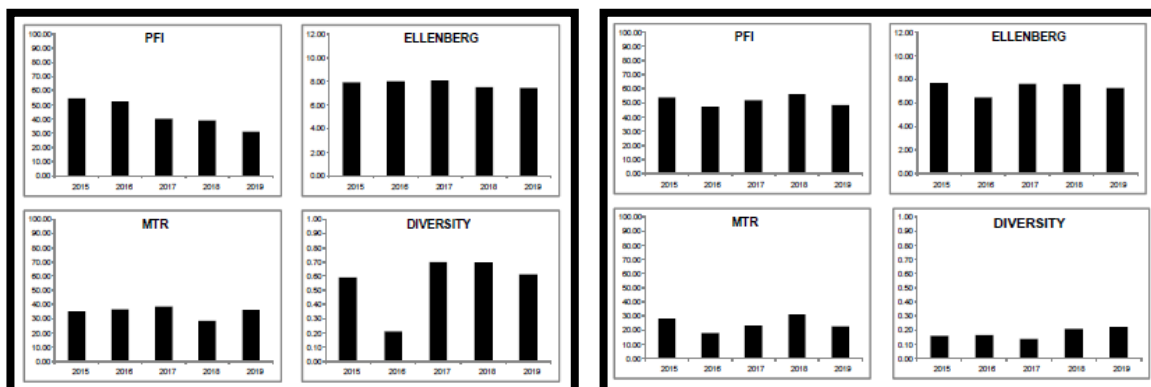


Figure 5. Examples of time series with PFI scores, abundance weighted Ellenberg scores, MTR scores and diversity indices for a site Downstream of Whitehall PS (left) and Frogmore Estate (right) during AMP6.

Identified Catchment Risks

The River Beane was identified by the Environment Agency as being affected by groundwater abstraction, with the frequent drying of the upper reaches attributed to abstraction impacts from Whitehall. Where there is flow downstream of the Stevenage Brook, the river is impacted by the presence of invasive species and numerous physical modifications, e.g. weirs and channelisation.

Water Framework Directive Classification

The River Beane Catchment consists of three WFD river waterbodies:

- *Beane (source to Stevenage Brook)*
- *Beane (from confluence with Stevenage Brook to Lee)*
- *Stevenage Brook*

Surface water bodies:

- *Beane (Source to Stevenage Brook)* (GB106038040110). **Ecological status: Poor**, and **Chemical status: Fail**. The Reasons for Not Achieving Good (RNAGs) include diffuse sources from agriculture and land management practices and physical modification of the river impacting invertebrates and phosphate as well as groundwater abstractions impacting ecology, phosphate, and the hydrological regime.
- *Beane (from confluence with Stevenage Brook to Lee)* (GB106038033310). **Ecological status: Poor**, and **Chemical status: Fail**. The RNAGs include diffuse sources of sediment from riparian activities and poor soil management impacting ecology, physical modification of the river impacting fish and groundwater abstractions affecting the hydrological regime and ecology of the river.
- *Stevenage Brook* (GB106038033410). **Ecological status: Poor**, and **Chemical status: Fail**. The RNAGs include diffuse sources from riparian activities and urbanisation and physical modification of the river impacting ecology, as well as groundwater abstractions affecting the hydrological regime and ecology of the river.

Groundwater bodies:

- The majority of the River Beane catchment is within the Upper Lee Chalk groundwater body (GB40601G602900).
- The overall status of the GWB is **Poor**. The RNAGs include diffuse sources from poor nutrient management and contaminated land as well as point sources from sewage discharges impacting the general chemical test, chemical drinking water protected area and trend assessments. Additionally, groundwater abstractions impact the water balance and the surface water body status as described above.

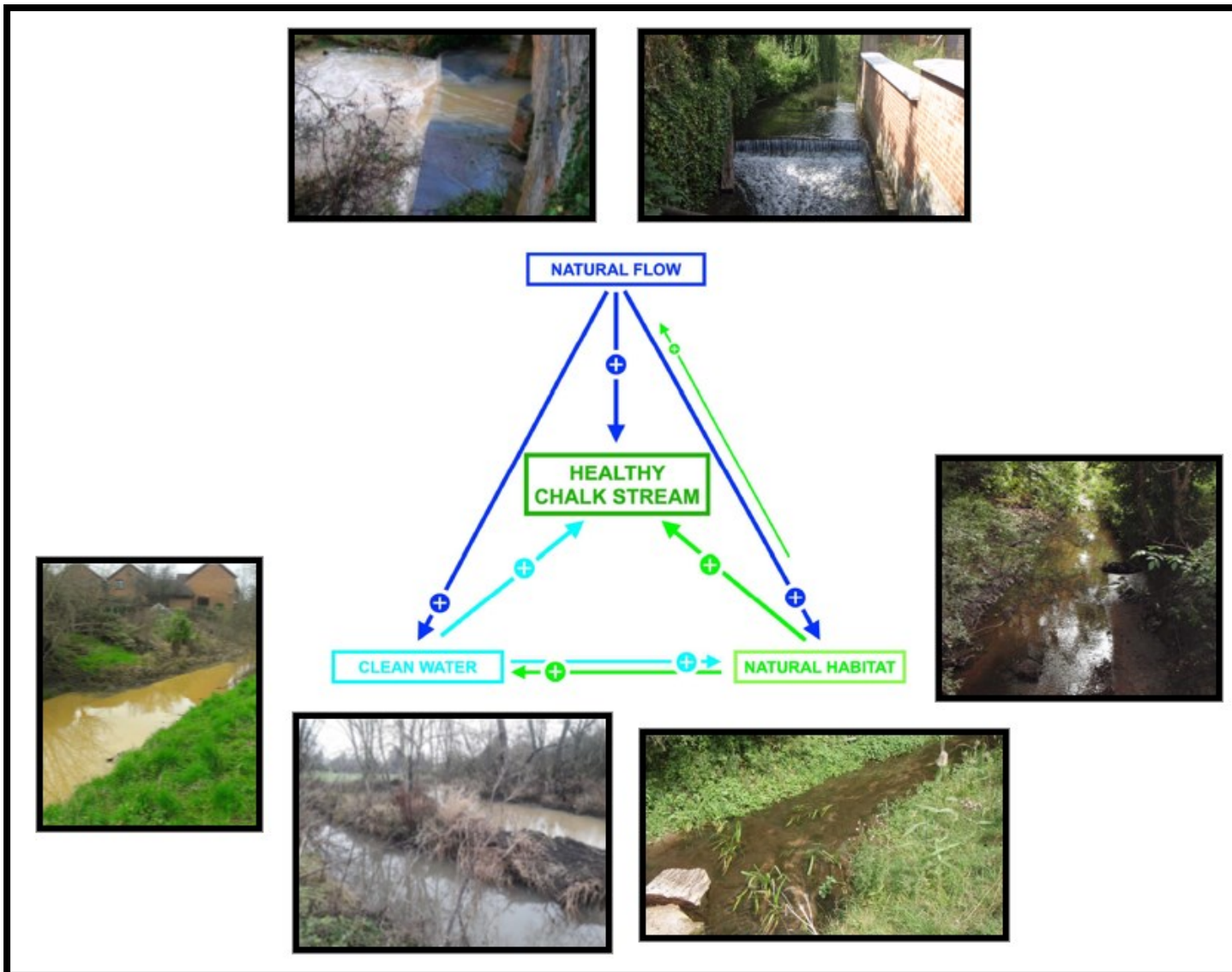


Figure 6. Photographic examples of barriers to achieving "healthy chalk stream" status in the Beane catchment.

Designations

Sites of Special Scientific Interest (SSSI):

- There are three SSSI's within the catchment most of which are either of **favourable recovering** or **favourable condition**.
- The catchment is situated on chalk geology and as such has a number of **chalk streams** which are rare and ecologically important habitats. These include the River Beane, Stevenage Brook, Dane End Tributary and the Old Bourne.

Water:

- The entire catchment is situated within a surface water and groundwater **Nitrate Vulnerable Zone (NVZ)** as well as a **Surface Water Drinking Water Safeguard Zone**. These two zones indicate catchment areas that influence the water quality of drinking water, protecting the areas at risk of failing.
- The catchment is within a number of **Source Protection Zones (SPZs)** which are defined around large and public potable groundwater abstraction sites to provide additional protection to safeguard drinking water quality. The entirety of the Beane catchment is located within Zone III (total catchment), land in the centre of the catchment extending to the south east is largely Zone II and there are small pockets across the middle of the catchment that are Zone I – the areas closest to a groundwater abstraction.

Priority Habitats

- The catchment is predominantly **rural** and used for **agriculture**, with the exception of the **town of Stevenage** in the western part of the catchment.
- Of the broad habitat types present, 77% of the catchment is classed as **Enclosed Farmland**, 19% is classed as **Urban** and 4% is classed as **Woodlands**. The main agricultural land cover type is **non-irrigated agricultural land** (CORINE 2018).

Water Quality

Nitrate in Chalk Groundwater

Nitrate is monitored for in the Chalk groundwater. An increasing trend in nitrate concentrations since the 1960's and 1970's (**Figure 7**) has been observed. Much of this nitrate is attributed to leaching from agricultural land and is expected to increase further in coming decade before declining from the 2030's onwards. This is due to legacy nitrate leaching which can take decades to move through the unsaturated zone and reach the aquifer. Nutrient management on farms is generally much better today than it was in the 1960's/70's with better regulation, understanding and precision fertiliser application techniques. However, despite these improvements around 40% of nitrogen applied to a growing crop is not used by the plants which risks losses of residual nitrogen to the environment through leaching or volatilisation into the air.

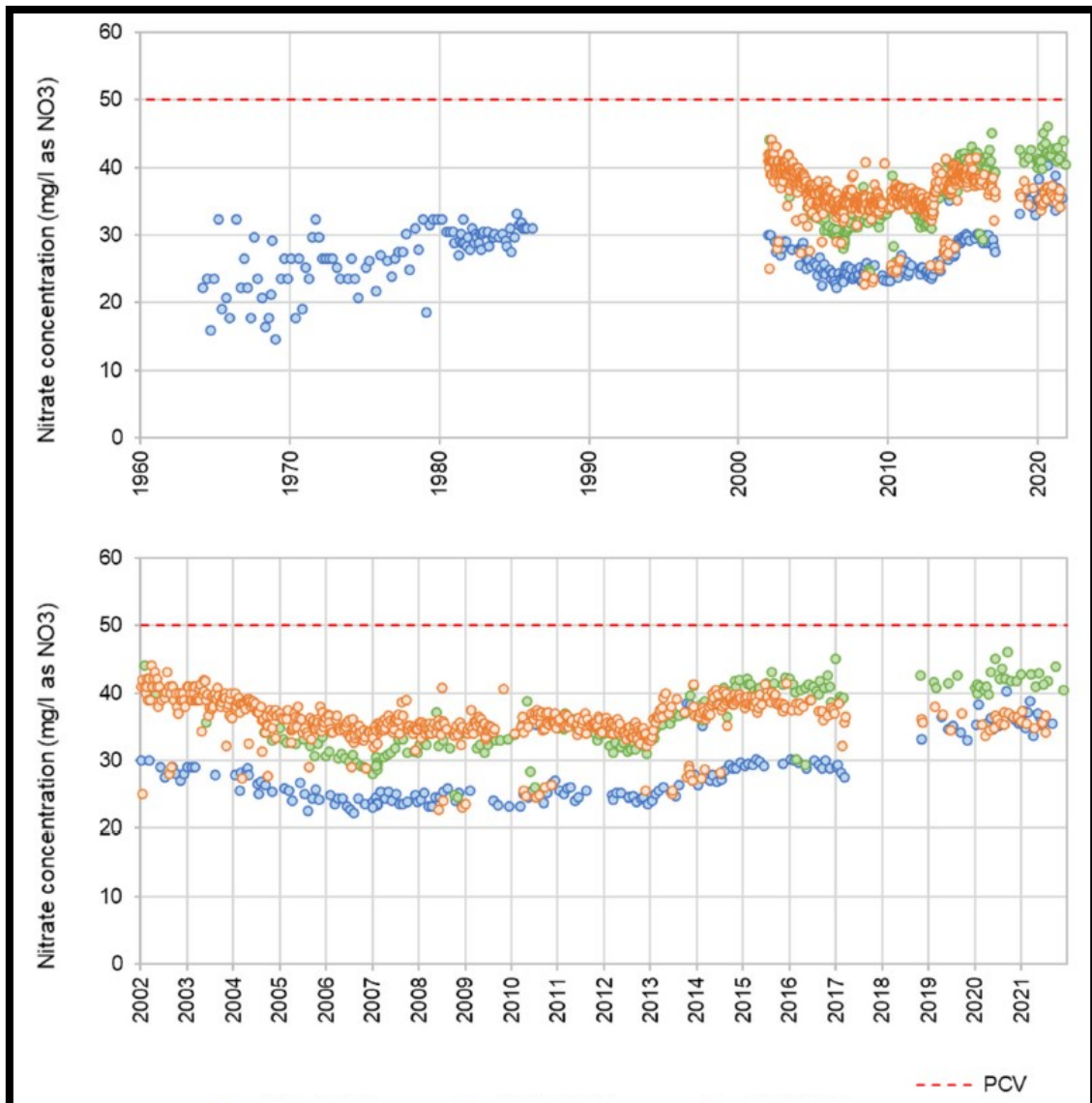


Figure 7. Nitrate concentrations in Chalk groundwater. Note: gap in data from the late 1980's until the early 2000's.

Nitrate in the River Beane

Affinity Water have been monitoring nitrate concentrations from across the Upper Lee catchment including the River Beane since 2017. Nitrate concentrations in the River Beane at Waterford are low when compared to other tributaries on the Lee such as the River Rib for example (**Figure 8**). One theory for this is that much of the flow of the River Beane is derived from the Stevenage Brook which has low Nitrate concentrations due to limited agricultural activity and no major sewage treatment works in the catchment.

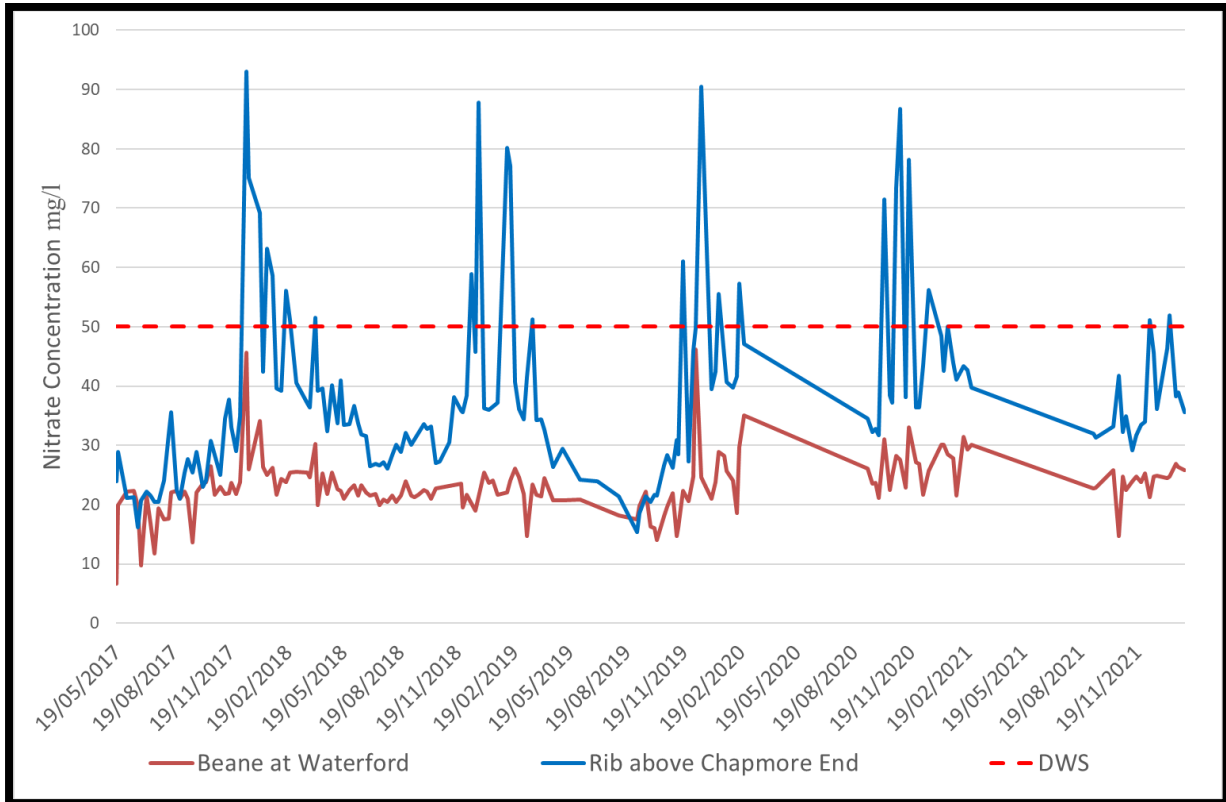


Figure 8. Nitrate concentrations in the River Beane and adjacent River Rib (DWS = Drinking Water Standard). Note: There is no public water supply abstraction from these rivers).

Pesticides in the River Beane

Affinity Water undertake regular pesticide monitoring of all major catchments across Hertfordshire including the River Beane. Pesticides in water have a drinking water standard of 0.1 µg/l and it is therefore useful to understand where these pesticides are coming from in the catchment to help target our catchment management work. We analyse for up to 13 different pesticide actives. It is worth noting that the drinking water standards for pesticides are not health based with the toxicity levels for each pesticide being many times higher than the drinking water standard.

Our monitoring shows that the River Beane does contain a many of these pesticides at differing concentrations throughout the year. Pesticide active ingredients such as metaldehyde (now banned for outdoor use), propyzamide and carbetamide all have been recorded and can pose a risk to downstream drinking water abstractions downstream from the River Beane on the River Lee. More importantly for the health of the river, many pesticides active ingredients have an Environmental Quality Standard (EQS) which indicates the concentration above which ecological harm may occur. For most pesticides detected the EQS is many times higher than what is observed in the main channel although it is possible that in the smaller ditches and tributaries, where pesticide concentrations tend to be higher, they may reach the EQS, although we do not routinely monitor small ditches or tributaries on the Beane to confirm this.

Turbidity in the Beane/Stevenage Brook

Although Affinity Water does not undertake quantitative samples of turbidity from the River Beane, ad hoc observations are made whilst sampling (**Figure 9**). The River Beane is known to become very turbid after heavy rainfall, especially in winter, with turbid water being seen at all sample points along the river. The source of this turbidity is likely to be from soil erosion, poached ground (**Figure 10**), road run-off and from urban areas.



Figure 9. The Stevenage Brook running turbid and having bursts its banks after heavy rainfall at Frogmore Park, September 2021.

Figure 10. Heavily poached ground on a field grazed by cattle next to the River Beane at Whitehall, January 2021.



Sampling Points

Affinity Water currently sample four points in the Beane catchment, shown in the table below:

Table 4. Water quality monitoring points in the Beane catchment.

Monitoring Point	Start Date
Beane at Aston End	2015
Beane at Waterford	2015
Stevenage Brook at Frogmore Park	2015
Dane End Tributary at Sacombe	2015

Affinity Water’s River Beane Catchment Projects

Sustainability Reductions

We have six public water supply (PWS) groundwater abstractions in the River Beane catchment listed in **Table 5**.

An AMP2 investigation identified that our Whitehall abstraction was having an impact on river flow in the mid-section of the River Beane. Following further investigations into the potential to relocate this abstraction to the lower catchment and associated discussions with the EA, we included in our WRMP14 and PR14 business plan submission a scheme to reduce abstraction from Whitehall and replace the lost Deployable Output (DO) by undertaking network modifications. To enable the Whitehall sustainability reduction to go ahead, a new 6km trunk main was constructed at a cost of c.£4 million. Site alterations at two sites were also required at a cost of c.£3 million.

Table 5. PWS groundwater abstraction in the River Beane Catchment with licensed abstraction pre- and post- sustainability reduction.

Pre-Sustainability Reduction		Post-Sustainability Reduction	
Average Annual Licence (MI/d)	Max Daily Licence (MI/d)	Average Annual Licence (MI/d)	Max Daily Licence (MI/d)
4.55	5.68	4.55	5.68
22.73	30.46	2.00	10.00
1.82	1.82	1.82	1.82
2.27	2.73	2.27	2.73
13.64	13.64	13.64	13.64
2.15	2.51	2.15	2.51
1.82	1.82	1.82	1.82
49.98	58.66	28.25	38.2

INNS Out Scheme

Affinity Water launched their INNS Out scheme, as part of their AMP7 Biodiversity Programme, to support stakeholders and local groups to manage invasive non-native species by providing funding and volunteer support. The RBRA have received support through the scheme over the last two years with a main focus being to manage Himalayan Balsam and Giant Hogweed.

River Restoration Morphological Works

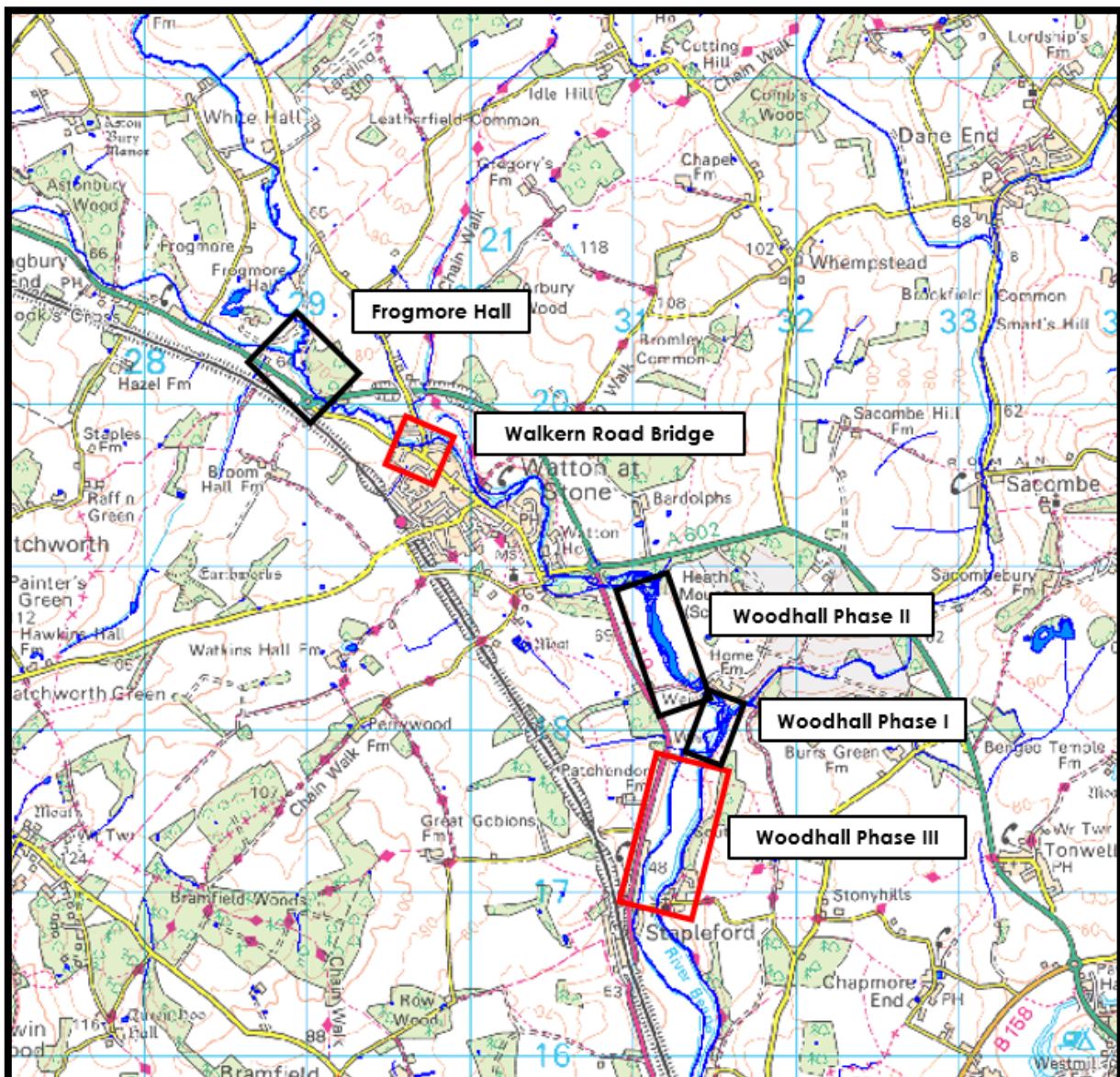


Figure 11. Map of Affinity Water's completed (in black) and proposed (in red) River Restoration projects in the Beane catchment. © Crown copyright and database rights 2022 Ordnance Survey 100022432.

Frogmore Hall

Work was undertaken at Frogmore Hall in October 2015. This work involved the removal of a small concrete weir which was installed in the 1920s (**Figure 12**). The weir disrupted the river's connectivity, impeding fish migration and caused siltation upstream as flows were slowed. The purpose of the weir removal was to improve flow velocities and encourage riverbed erosion, exposing the gravel that lies underneath. Gravel provides a habitat for a wider range of invertebrates than silt and is vital for trout and many other species of fish to spawn. Trees located near the site were also thinned out, allowing more light into the channel, encouraging more riparian and aquatic plants to grow. This, in turn, helps to stabilise the banks, diversify habitats, further improve the velocities and provide cover and refuge for fish and aquatic invertebrates.



Figure 12. Weir removal at Frogmore Hall.

Figure 13. Horseshoe weir at Woodhall Estate.

Woodhall Phase I

The River Beane flows over two significant weirs within the Woodhall Estate: the Tumbling Bay weir and the Horseshoe weir, a Grade II listed parkland located near Stevenage. The horseshoe weir was acting as a barrier to fish passage and impounded flow upstream (**Figure 13**). The section of river upstream of the weir was artificially straightened and had little natural chalk stream features. The weir is ornamental only and has a Grade II listing and hence could not be removed. To enable fish to migrate upstream, and to create a more naturally functioning chalk stream reach, it was decided that the weir needed to be circumvented by means of a bypass channel.

Aerial photographs showed that the field to the west of the channel, which was used for grazing cattle, was likely the original route of the Beane (**Figure 14**). The Woodhall Estate agreed that we could use some of the grazing field to reinstate the river channel back to its more natural pathway, where it would be connected to the groundwater, which allowed for a bypass of the horseshoe weir with the additional benefit of better groundwater connectivity and more natural chalk stream features.

Riffles, pools and berms were created in the new channel to provide a range of habitats along the stretch (**Figure 15**). Local gravels were used to create the riffle

features and mimic the appearance and natural characteristics of a chalk stream. The Woodhall Estate have planted a number of tree standards on the right-hand side of the new channel to create an area of wet woodland. Fencing has been installed so that the rest of the field can be grazed again, without the risk of poaching. As part of the project, a volunteer day was held with Affinity Water staff, staff from the Estate, and members of RBRA to rescue aquatic and marginal plants from the drained down Broadwater before the silt was removed from it and it was refilled. In the summer of 2017, the plants were dug up, potted and kept in the offline section of the old channel over winter. In spring 2018 they were added to the berms by the Estate staff to encourage native species to vegetate in the new channel over the summer.



Figure 14. South-facing aerial image of grazing field adjacent to channel with evidence of historic channel location.



Figure 15. North-facing aerial image of Woodhall Phase I's new channel.

Woodhall Phase II

Phase II of the project at Woodhall followed on from the completion of Phase I. The listed Tumbling Bay weir is located south of the Broadwater which forms part of the listed parkland. The Broadwater is classed as Main River and, by its nature of being a lake, was not conducive with a healthy chalk stream habitat. Over numerous years, the Broadwater had filled with contaminated silt and which were left exposed by a breach its bank in April 2016. The Woodhall Estate wished to remove the silt, and have it treated so it could be spread safely on the farmland. The banks of the Broadwater and the sluice gate of the Tumbling Bay Weir required repair and maintenance so the Estate could maintain better control during high intensity rainfall and flow events. We took the opportunity while the banks were being repaired to improve the connectivity of the river by bypassing both the weir and the Broadwater with a new channel approximately 700m in length.

The objective of Phase II was to improve fish passage, create a range of chalk stream habitats, and to split the flow of the River Beane between the new channel and the Broadwater. This enabled the lake feature to be retained as part of the parkland, but also allow wildlife to flourish in the flowing channel by creating multiple habitats. The new channel was made live in 2019 and features a series of natural pool and riffle sequences as should be seen in a chalk stream (**Figure 16**). The bed has been gravel-lined and low berms have been installed which will encourage the growth of marginal plants like watercress. The shallow fast flowing water with gravel bed will encourage the growth of chalk stream species like ranunculus and starwort. Deeper pool areas will provide good habitat for juvenile and adult fish while the in-channel and marginal vegetation will create refuge areas for small fry. Furthermore, bypassing the Tumbling Bay weir will allow fish to migrate further upstream. The project was completed at the end of 2019 and reconnects a length of ~6km between the next upstream and downstream structures.

Figure 16. Aerial image of the Broadwater and the new adjacent bypass channel.



Working at Catchment Scale

Farm Engagement

The Affinity Water catchment team have been working with farmers in the River Beane catchment for over 5 years. Our most high-profile engagement is with the Groundswell event which takes place at Weston Park Farms at the very northwest of the catchment (**Figure 17**). The event is the largest regenerative agriculture event in the UK, and possibly Europe, and attracts over 5,000 farmers from across the UK and further afield to learn and share knowledge on a whole range of farming, sustainability, and biodiversity topics. The event also has a significant local profile with many farmers attending who farm in the River Beane catchment. The presence of such a high-profile event has meant that local farmers have had access to some of the world's very best proponents of regenerative agriculture which has helped spread knowledge and uptake of these farming techniques. Affinity Water have sponsored this event since 2018 as recognition of its important role in expanding regenerative agriculture.



Figure 17. Groundswell Regenerative Farming Show 2022. Weston, Hertfordshire.

As well as supporting Groundswell and regenerative farming practices we have also provided farmers with funding to grow cover crops in the catchment. Since 2019, we have run a funding scheme, using the platform EnTrade, to encourage greater uptake of cover crops in north Hertfordshire which has covered the northern part of the Beane catchment. Cover cropping is the practice of covering land over winter with a growing crop which may otherwise be left bare. Cover crops reduce soil erosion and reduce nitrate leaching, both of which can impact the water environment. Cover crops also help build soil organic matter which in turn can increase infiltration and have a higher water holding capacity both of which also benefit river catchments. Since 2019, we have funded over 2,000 hectares of cover crops (note, not all of these are in the River Beane) across the target area (**Figure 18**).

Cover crops are a useful way of reducing soil erosion and leaching on fields that would otherwise be bare over winter (**Figure 20**). However, despite relative success of the EnTrade funding project it should be acknowledged that this still impacts on a small portion of the overall catchment on an annual basis. Soil erosion is likely to contribute to frequent high turbidity concentrations in the river which may be due to maize production for anaerobic digestate power plants and conventional farming practices such as ploughing, which are still dominant in the catchment despite the presence of a number of regenerative farmers in the catchment. To truly impact soil erosion and the resulting sedimentation of rivers a wider range of changes are needed to be implemented including sources from urban areas and rural roads. Silt traps, swales and wetland areas able to capture silt should all be considered alongside the overall ambition of improving soil management in the catchment.

In February 2022, the inaugural meeting of the River Beane Farmer Cluster was held near Stevenage. The meeting was attended by over 20 local farmers, Affinity Water and the Farming and Wildlife Advisory Group East. The cluster, the facilitation of which is being funded by Affinity Water, aims to bring farmers together in the catchment to work on collaborative catchment scale initiatives that benefit the whole river catchment and the wider environment. To realise the ambitions of the flagship restoration landowners and farmers will be a key stakeholder so the cluster will be a key route for delivering catchment scale change. Affinity Water have committed to fund the facilitation of the cluster until at least 2025.

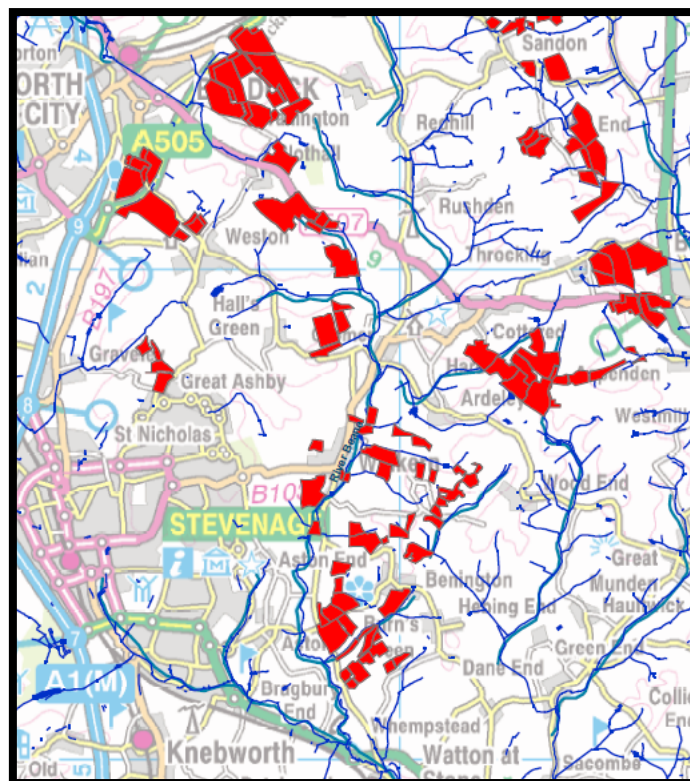


Figure 18. Map showing fields that were funded by Affinity Water to grow cover crops as part of the EnTrade cover crop scheme from 2019 - 2022. © Crown copyright and database rights 2022 Ordnance Survey 100022432.



Figure 19. Photo of an Affinity Water funded field of cover crops next to a widened and deepened section of the River Beane near Walkern.



Figure 20. Field of cover crops funded by Affinity Water in the River Beane catchment near Walkern.

PhD Studentship

We are funding a PhD studentship at the University of Reading entitled: *Using simple spectral technology to engage farmers in building soil health to enhance environmental outcomes*. It is hoped that this studentship will help build an understanding of how simple techniques can help farmers monitor improvements to their soil health, in particular soil organic matter. Improving soil health is a key aim of the Affinity Water catchment team to help build resilience in our catchments so this studentship will improve knowledge in this area. The River Beane catchment will be used as a study site for the PhD student where they will engage with farmers to monitor soil health and relate this to agricultural practices. The student has already engaged with the farmer cluster and has visited several farms in the Beane to take soil samples. This studentship will run for 4 years and is due to be completed by 2025. The outputs of this PhD to support this project will include:

- Spatial understanding of soil health in the Beane catchment
- Where targeted support, incentives and investment in improving soil health to benefit hydrology and reduced sediment loss to water can be made
- Closer working relationships with land managers in the catchment
- Outputs could support development of a future ELMS scheme with the farm cluster group focused on improving soil husbandry, agricultural sustainability and productivity and chalk stream resilience

Dane End Tributary Natural Flood Management feasibility study

The Dane End Tributary is a sub-catchment of the River Beane in the east of the catchment that joins the River Beane downstream of Watton-at-Stone at Woodhall Estate. The tributary is an ephemeral stream that is straightened and deepened for much of its length (**Figure 21**) and is dry for most of the year and only flows after sustained winter rainfall. Whilst this tributary is not considered to be a chalk stream due to the underlying geology in this part of the catchment, the Dane End Tributary has the potential to significantly impact flows and water quality in the main river. In exceptionally wet periods the catchment can cause flooding at Sacombe Pound where Affinity Water have a groundwater source. The floods have caused access issues and risks to the site in both 2014 and 2021. In 2022, Affinity Water commissioned a Natural Flood Management feasibility study which is being delivered by Atkins. The study aims to understand the nature of the flood risk now and into the future and what natural flood management options are available in the catchment to help mitigate the flooding issue. As well as mitigating flood risk it is also the aim to maximise any wider natural capital such as biodiversity and climate change mitigation through any interventions that may be funded. The feasibility study is due for completion in October 2022 with the outputs being used to assist with PR24 business planning.



Figure 21. Dane End Tributary. Dry, straightened and deepened channel.

Landscape Enterprise Networks East of England project (LENs East)

The LENS east project was set up in 2021 driven by the need to bring together different funding streams aiming towards improving landscapes through working with agricultural supply chains. Recognising that in the east of England farming is an important and productive land use, working with farmers is key to realising landscape scale improvements. Companies such as Nestlé and Cargill rely on the farmed landscape to provide them with the raw products needed to manufacture their food products. These companies are investing money in the sum of multi-millions to help the farmers that supply their raw products such as wheat to be more regenerative and sustainable. Practices such as reducing tillage, growing cover crops and improving farm biodiversity are some of the measures that the food producers are willing to fund. These measures have the potential to also be beneficial for river catchments. On top of the food producer's commitment other organisations such as water companies (Affinity Water, Anglian Water and Cambridge Water) and county councils are funders and committed to part funding some of the measures that will have benefits for their own drivers such as water quality improvements or carbon offsetting.

As a project partner Affinity Water has nominated the Upper Lee Operational catchment which includes the River Beane as a target catchment for co-funding of measures through the LENS east project. Although thus far no measures have been funded in the River Beane catchment, it is hoped that future rounds of this project will lead to funding in the River Beane leading to environmental improvements.

River Beane Natural Capital Account

In 2022, Affinity Water commissioned Atkins to deliver a study which will create a Natural Capital Account to understand the stocks of natural capital within the Beane catchment, and the flows of ecosystem service benefits they provide. The study considers the whole Beane catchment area which covers 17,300 hectares.

The purpose of this work has been firstly to produce a basic Natural Capital Account which can use as a baseline when quantifying the wider benefits generated by investing in river improvement works, cover cropping, sustainable abstraction reductions, and invasive non-native species (INNS) removals projects, such as through Affinity Water's Water Industry National Environment Programme (WINEP).

Another purpose of the Account is to help develop a more integrated, place-based approach to planning investments in the catchment and developing a shared vision for the catchment with the local community and relevant stakeholders.

Catchment Assets for Water – SERT

South East Rivers Trust (SERT) have worked on developing an approach to spatial planning, targeting and quantification of the opportunity and estimated impact of nature based solutions as part of PROWATER, with Affinity Water as an Observer Partner organisation. Affinity Water have commissioned SERT to expand this approach, as a partnership project with SERT, to two further catchments to support the integration of nature-based solutions at a catchment scale in water resource planning.

The work aims to support Affinity Water's ambition to take an evidence-led, catchment-scale approach to delivering nature-based solutions for increased resilience of water resources in the Lea and Colne catchments. It is mainly a desk-based assessment using data provided by Affinity Water and accessible through the catchment partnerships. Additionally, SERT and Affinity Water engaged with local catchment partnerships to create familiarity with the approach, take account of local knowledge and data, and support the partnership in using and applying outputs down the line. While the focus of the work will be on natural assets for water resources, it will aim to take account of water quality and biodiversity as well as wider benefits where possible.

Wider Catchment Ambitions

Environment Agency HNL Water Environment Vision 2100 – Beane Catchment

The Environment Agency Herts and North London team for which the River Beane catchment is located within are developing a Water Environment Vision 2100. As part of this they are currently developing a supporting Beane Catchment Vision document through the Lee2100 core team. The 'vision' states:

All rivers, groundwater, aquatic ecosystems and wetlands are restored and protected.

- All WFD rivers and groundwater bodies support Water Framework Directive good ecological status / potential.
- Aquatic ecosystems (including wetlands) are resilient to extreme weather conditions, including high and low flows, and the impacts of climate change
- in-channel, marginal and riparian habitats are restored and defragmented.

Communities and stakeholders are engaged in restoring the water environment and become more self-aware of their individual impacts as a result.

Through the development of the Catchment Strategy for the Beane under this Flagship project alignment will be made between the Water Environment Vision 2100, alongside the current Catchment Plan developed through the Lea Catchment Partnership.

HMWT Hertfordshire State of Nature Report and Targets

In 2020, HMWT published the Hertfordshire State of Nature Report which brings together the story of Hertfordshire's wildlife over the past 50 years. The report assesses over 7,500 different species and how their numbers have changed between 1970 and 2020. The results are based on over 2.8 million species records held by the Herts Environmental Records Centre.

The report looks at both habitats – such as woodlands, grasslands and wetlands – and species to give a clear picture as to how the country's wildlife has changed over the last 50 years. This highlights what has been lost over the last 50 years and just how many species are now threatened with extinction in Hertfordshire. It concludes that to halt and reverse the decline, it is important to act now and focus on reinstating conservation management of existing habitats as well as creating and connecting

habitats across the county. It also highlights that partnership working will be the key to achieving this. Through this Flagship project we will work in partnership with HMWT to support the target of 30% of land in that can support spatial connectivity of species.

HMWT Water Vole Reintroduction

In July 2022, Herts and Middlesex Wildlife Trust released 138 water voles at Woodhall Estate with support from the RBRA. Loss of quality wetland habitat and predation by invasive non-native species has caused water vole populations to decline significantly over the last 50 years with the last recorded population in the River Beane catchment in 2000. The Woodhall Estate was chosen as a release site due to their commitment to conservation and overall river habitat suitability. Continued engagement with HMWT is important to track the success of the reintroduction and to ensure future projects in the Beane compliments and monitors any additional benefits to water voles.

Thames Drainage and Wastewater Management Plan

Drainage and Wastewater Management Plans (DWMPs) are new long-term plans that will make sure we have a resilient and sustainable wastewater service for the next 25 years, and beyond.

Thames Water are the sole wastewater provider in the Beane catchment. Their draft DWMP was out for consultation between 30 June until 22 September 2022 (**Figure 22**). Their final DWMP will be published in March 2023.

Thames Water Catchment Management Programme

Thames Water run a catchment fund in parts of the upper lee, including the River Beane catchment. The fund is aimed at assisting farmers to reduce diffuse pollution which can affect their water abstractions from the River Lee in north London. Farmers can apply for up to £10,000 for options such as cover crops, under sowing maize and buffer strips next to water courses.

Environmental Land Management Scheme (ELMs)

It is hoped that the flagship restoration project can utilise funding through the developing Environmental Land Management scheme to deliver some of the improvements needed. Funding for improvements to soil health on farmed land and landscape recovery will be explored. Once further details are released on ELMs it will be incorporated into the long-term plan for the River Beane catchment.

Our preferred 25 year plan for Hertfordshire

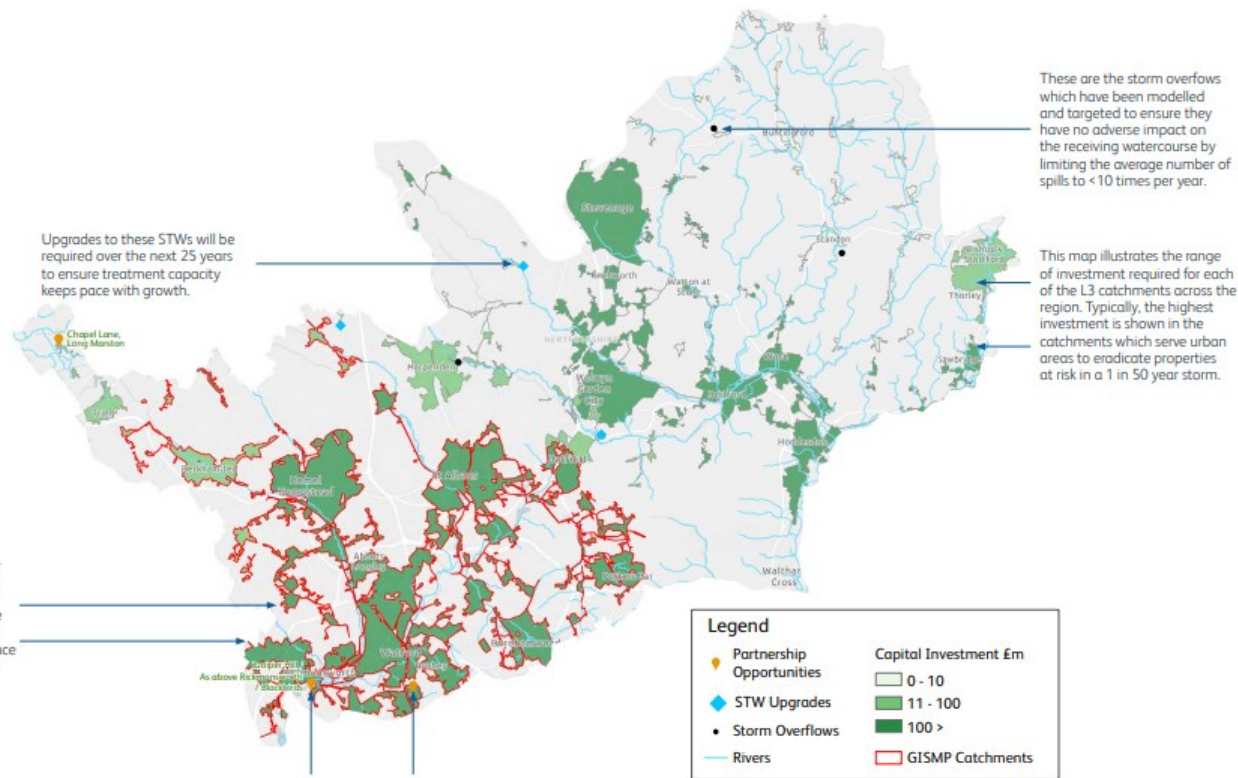


Figure 22. Thames Water's preferred DWMP for Hertfordshire (Link [here](#)).

Current and Future Work

In order to achieve a healthy chalk stream, we consider these pressures would be best addressed at a landscape scale, through an integrated and holistic approach. To develop the flagship project, we will look to establish a core working group building on the existing contacts. We will lead the group and work with the Environment Agency, local interest groups, catchment partnerships, the Wildlife Trust, farmer representatives, local authorities, lead local flood authority and the large estates within the catchment to establish this. We will also engage with Thames Water as the wastewater undertaker for the catchment and in relation to their abstractions downstream in the Lea catchment.

Subject to PR24 funding, through the working group we propose to develop baseline metrics and deliverables around a number of ecosystem services under a natural capital framework, to be delivered in collaboration with stakeholders over the 2025 - 35 period. This would include water supply, water quality, water flow regulation, food, soil health, biodiversity and recreation. These actions would be set out in an adaptive catchment plan to achieve a set of agreed outcomes and will be accompanied with a monitoring plan. This will allow the benefits of schemes to be assessed, helping to inform future options and decision making. We already have an extensive monitoring programme in the catchment, which is supplemented by data collected by the RBRA and Riverfly monitoring group.

Flagship Project Scoping Workshop

The first CaBA Flagship Chalk Stream Restoration Project scoping workshop was hosted on the 19 August 2022 with members of the Environment Agency, Hertfordshire and Middlesex Wildlife Trust, Natural England, Hertfordshire County Council, the River Beane Restoration Association and other local stakeholders. Attendees were placed into groups and asked to highlight their most desired outcomes for the Flagship project within the Beane catchment and select their top three. The results for each group are shown in **Figure 23**.

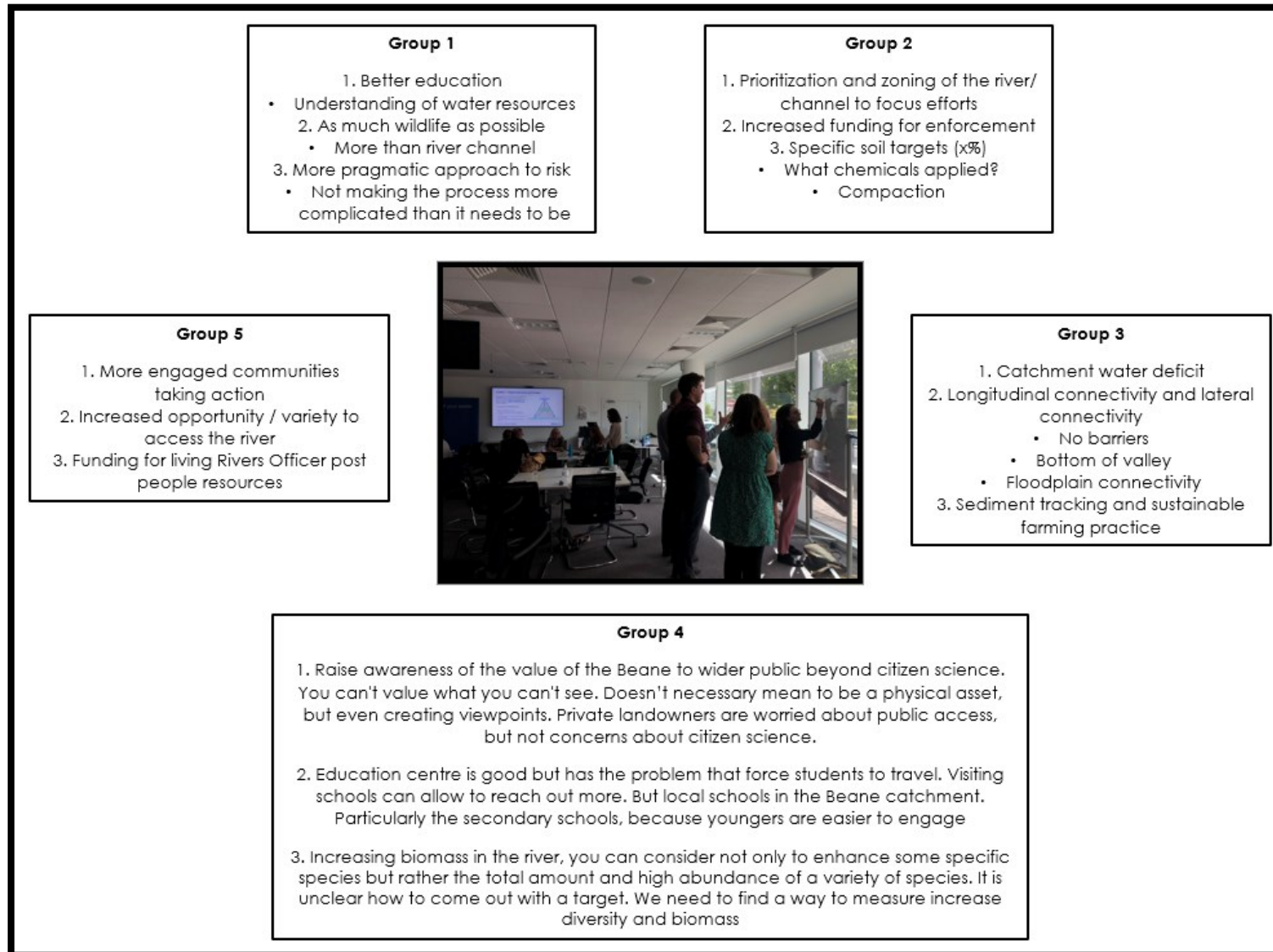


Figure 23. Results of each group from the first CaBA Flagship Chalk Stream Restoration project meeting.

The evidence from the initial workshop highlights that there are a variety of issues and challenges within the Beane catchment and that increased stakeholder engagement and awareness building will be an important aspect of this project. Affinity Water aim to build on these initial ideas at future workshops and steering group meetings. Our initial draft plan for the next 10 years and beyond is detailed below:

The 10-year+ Plan

At the time of writing Affinity Water are preparing their PR24 WINEP submissions which will include a scheme for this Flagship proposal under the 25YEP Driver. It is recognised that we are also halfway through AMP7 where a number of projects and initiatives are already underway in the River Beane which will assist in the long-term restoration strategy. We highlight below the proposed plan for the next 10 years and beyond, subject to securing funding, and which has been structured in the chronology of water company AMP cycles.

2022 - 25 (AMP7)

- Determine the key stakeholders and establish a partnership working group (2022). Note the first workshop was held in August 2022.
- Undertake a review of the existing catchment partnership Catchment Plan with key stakeholders and use the outcomes to support develop of the Catchment Strategy for this project with key stakeholders and partner organisations ensuring alignment with existing and wider plans/ambitions (2022 - 24).
 - Set up a steering group to meet at regular intervals throughout the year
 - Identify an external lead partner to evaluate risks/issues and benefits
 - Identify key local stakeholders to champion the project
- Identify key species to champion through the project e.g. water vole, brown trout (2023).
- Review the existing multi-stakeholder catchment monitoring and plan an enhanced monitoring network – (2022 - 2023)
 - Perform an assessment of historic monitoring data, gap analysis, and consider an enhanced citizen science monitoring plan.
 - Things to consider include: water quality, flow, groundwater levels, ecological surveys, turbidity, invasive non-native species (INNS) mapping, sediment fingerprinting, urban outfalls, agricultural land drainage and point source mapping.
 - Include regulatory data gathered from the EA, Affinity Water and Thames Water as well as other organisations data and citizen science

- Continuation of the Catchment Assets for Water Project – Affinity Water and South East Rivers Trust are utilising the methodology developed under the [Interreg PROWATER](#) project (2022)
 - Create a spatial Catchment & Nature Based Solutions (C&NBS) opportunity map for the whole catchment – Developed with input and review from partners throughout the process.
 - The project will focus on enhancing water resources and wider natural capital through C&NBS.
 - The outputs will be collated with the WRSE catchment outputs and together will form the basis for WRMP/PR24 C&NBS options appraisal and costs.
- Continuation of the 'Chalk Stream Friendly Farming' project (ongoing – wider Lea catchment 2020 – 2025)
 - Continuation of the funding scheme for cover crops plus developing further offers such as companion cropping, soil health assessments and targeted arable reversion.
 - Develop the River Beane Farmer Cluster. Set up a steering group with engaged farmers to shape and steer the direction of the cluster. Host a range of farmer workshops over the winter.
- Support Groundswell event on an annual basis to spread the uptake of regenerative farming practices in the catchment.
 - Host local events in the catchment focusing on regenerative farming.
- Continue to deliver the INNS Out scheme where funding is given to local community groups to help with the control of INNS.
- Explore other funding avenues such as the OFWAT innovation fund.
- Continuation of the PhD study: Using spectral technology to engage farmers in building soil health to enhance environmental outcomes (commenced 2021 - 2025)
 - Focus on the River Beane to assess soil health and risk to water with recommendations for enhanced soil management
- Following the completion of the Dane End Tributary Natural Flood Management feasibility study assess where low cost NFM measures can be implemented such as leaky dams (2023 - 25).

2025 - 2035 (AMP8 & AMP9)

The following proposals are subject to PR24 WINEP funding

- Identify options and mechanism to set up a community fund to support local stakeholders to deliver benefits to the River Beane.
- Use the outputs from the Catchment Assets for Water Project to plan and deliver C&NBS in the catchment e.g. wetland creation, targeted land use change, regenerative farming.
- Continuation of the 'Chalk Stream Friendly Farming' project
 - Consider engaging the local community through assisting with events such as Local Farm Sunday, where the public are invited on farms to learn about food production and the local environment.
- Perform a full geomorphological survey of all reaches of the Beane with a reach-by-reach condition assessment
 - Perform a cost assessment of restoring each reach to GES
- Map all Sewage Treatment Works and work with Thames Water to identify other nutrient point sources, e.g. misconnections
- Use the outputs of the Dane End Tributary Natural Flood Management feasibility study to deliver significant NFM measures in the catchment with associated natural capital gains e.g. tree planting, wetland creation and off-line storage.
- Engage with members of the public to raise awareness of the catchment and what action each individual can take to play their part in protection the river e.g. reducing their water usage, rain gardens, urban suds, volunteering.
- Plan a flagship catchment wide project such as creating at least a 20 'wild corridor' along the length of the main channel.
 - This could be part funded by ELMS as a Local Nature Recovery (LNR) project or other private finance initiatives such as the LENS east project.
- Utilise private finance initiatives to direct funding into the catchment for actions such as carbon offsetting (e.g. tree planting, soil restoration, wetland creation) and Biodiversity Net Gain.
- River Restoration: to deliver a number of projects in the River Beane subject to PR24 WINEP approval of funds.
- Deliver a project to map out historic drainage management and associated existing infrastructure ownership.
 - Look at current vs historic management including an assessment of investment in SUDs programme for Stevenage

Draft Budget

2022 - 25 (AMP7)

This chalk stream flagship project was not included in our PR19 business plan submission but a number of our ongoing WINEP commitments will assist with the ambitions of the flagship restoration. We will continue to work on the development of the flagship restoration project and associated catchment strategy for the remainder of AMP7.

2025 - 30 (AMP8 & AMP9)

We are currently preparing our PR24 WINEP submission but at present our current preferred option for the flagship restoration project will be included under the WFD_Flow_IMP WINEP primary driver and 25YEP secondary driver. Total proposed budget for AMP8 (as of October 2022) is estimated at c.£2.6m. It is important to note that this funding allocation is subject to approval under the WINEP and PR24 business plan process.

We anticipate further costs to be identified and developed for the PR29 WINEP submission. We currently estimate this to be c.£2.5m. However, this will be subject to further investigation and refinement as part of the development of the Catchment Plan, outcomes of the geomorphological survey of the Beane and the reach-by-reach condition assessment.

In addition, we will work with stakeholders in the catchment to explore, identify and obtain wider funding opportunities which could include, but not limited to: LENS co-funding; Environmental Land Management Scheme (ELMS) local nature and/or landscape recovery schemes; Biodiversity Net Gain and Section 106 funding opportunities.

Links

Mural board of Beane Chalk Stream Restoration Project Workshop outputs:

(<https://app.mural.co/t/riverbeanecatchment3847/m/riverbeanecatchment3847/1662128007936/46adf7955eebc03090cf28387a23e7db27b09e0c?sender=u54248ef86bdfc27229dc4168>)